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Tuned Mass Dampers for the Olympic Symbol of Torino

By means of innovative magneto-rheological tuned mass dampers, the footbridge Ponte MOI is „calmed down“.

Munich/Torino. It is the magnificent symbol of Torino and ist Winter Olympics: the skew red arch of the bridge „Ponte MOI“. For the engineers however this arch posed a challenge, because the arch had the function of a pylon, to which a vibration prone pedestrian cable stayed bridge is suspended. Maurer Söhne, expert for structural protection systems, solved the problem in 2 ways: innovative magneto-rheologic tuned mass dampers will take care of the horizontal vibrations, and hydraulic dampers at the ends of the bridge of the torsional and horizontal vibrations.

Furthermore, the Munich based company supplied the spherical bearings, which support the distinctive red arch.

It is the former gross market area, which is now home of the Olympic Village, and which lends its name to the pedestrian and bicycle bridge Ponte MOI. About 4 m wide and 368 m long, the MOI bridges the railway area of Torino and links the Ice Skating Hall with the Olympic Village. In ground view, the steel bridge is slightly curved. About 230 m are designed as cable stayed bridge, of which 156 m span the railway tracks.

The „pylon“ is an impressive eye catcher, built to the design of the French architect Hugh Dutton, being of the shape of a huge red steel arch. Its height is 69 m, and this in inclined position. Vertically erected it would be 85 m high. The distance between the supports of the arch is 55 m.

These supports were designed as so called „springer bearings“ with their position perpendicular to the axis of the arch. Besides the



dead weight of the arch (460 t) and the dead weight of the bridge (660 t), it is the tensile forces in the stay cables that additionally act upon the bearings. In addition, the bearings have to accommodate a rotation of 3%. These structural requirements are met by fixed MSM spherical bearings, taking loads of 25,000 kN each. MSM, the innovative sliding material developed by Maurer Söhne, was applied in this project, because it can accommodate by far higher stresses than the conventional PTFE. Further, Torino also was the first location in Italy which received MSM bearings.

Vibrations that almost cannot be analysed

In comparison to the vibration issue, for the engineers the case with the spherical bearings was just a beginner's exercise. The vibration experts of Ove Arup (well known from the Millenium Bridge in London) were entrusted with the analysis of the vibrations. The steel arch, the steel bridge which just consists of 2 main girders as well as cross girders with a spacing of 3 m, and the 32 stay cables of a length of up to 113 m are exposed to various vibrational excitations: Wind, rain, and – most difficult to analyse – the human being.

During the predesign of the vertical, horizontal and torsional vibrations at the Ponte MOI, 20 vibrational modes could be found to be in the critical range. Critical are vibrations when their natural frequency is in the range of the pedestrian step frequency. In that case, knowingly or unknowingly, the human being can incite resonance vibrations into the structure, which make a comfortable passing of the bridge almost impossible. As a countermeasure, 2 new innovative, semiactive, that is self regulating, horizontal tuned mass dampers as well as 2 hydraulic dampers were installed.

Self regulating tuned mass dampers with a wide preset range of the frequency to be tuned

In order to damp the particularly critical horizontal vibrations, about in the centre of the bridge and lateral to the bridge axis, 2 innovative tuned



mass dampers with a mass of each 4 t and an amplitude of ± 200 mm are installed.

What is new is the electronic presetting of the damping parameter. This damping parameter regulates itself by means of a magneto-rheologic system. This technology was developed by Maurer Söhne, within the frame of the SPACE project which is sponsored by the European Union. The Ponte MOI is the first pedestrian bridge which by design receives such self regulating dampers. The damping range of the 2 tuned mass dampers (TMDs) differ. 3 to 3.4 kNsec/m respectively 4 to 5 kNsec/m.

A second particularity of the TMDs is that they are predesigned with an enormous frequency range, and only on site need to be finetuned to the requirements of the bridge. This way the problem is overcome that the eigenfrequencies of the bridge cannot be calculated exactly enough. The 2 TMDs of almost identical design cover different frequency ranges: the first one caters to a frequency range of 0.55 to 0.75 Hz, and is preset to 0.65 Hz. By means of 10 exchangeable respectively removable springs, that is 5 at each side of the vibrating mass of the TMD, the frequency can be preset to an exactness of 0.01 Hz. The second TMD caters for a frequency range of 0.65 Hz to 0.95 Hz, and is preset to 0.76 Hz.

Particularly tight requirements for the hydraulic dampers

Where the main bridge links to the adjacent bridge, 2 hydraulic dampers are installed in longitudinal direction, in order to damp the movements caused by torsional and horizontal vibrations. The advantage of these dampers is that they need not be preset to a certain frequency range. However, they are only activated at certain movements or velocities. They function similarly like car shock absorbers, however they have to be exactly set to the bridge parameters, thereby fulfilling the following requirements: The maximum damper force is 150 kN, the damping 3.5 MNsec/m. During a period of 30 sec the dampers must be able to provide a



power of up to 3.2 kW, and 1.1 kW without time limit. Thereby the dampers may not incur deformations of more than 2 mm, and the permissible clearance in the fixation elements thus only is 0.02 mm.

At slow movements, the dampers further may not enact a resistance force exceeding 50 N, which is an extremely low value. The checking of the functionality of the dampers will be carried out at the University of the Armed Forces in Munich.

In fulfilling all these requirements, Maurer Söhne once more demonstrated to be a company that through its technical competence can master difficult and complex challenges. In this project, the decisive difference for the project owner, which was a joint venture of Falcone Steel Construction and Sermeca Façade Construction, to award this project to Maurer Söhne were the technical special proposals made by Maurer Söhne, to get the very difficult to analyse dynamic performance of this spectacular bridge under control. Installation of the tuned mass dampers and the hydraulic dampers will be carried out in March 2006.

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The red steel arch that serves as a pylon for the cable stayed bridge is inclined at an angle of about 27°. The fixed MSM spherical bearings accommodate a rotation of 3% and are designed for a vertical load of 25,000 kN.

Photo: Maurer Söhne

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Optically an eye catcher – technically a challenge due to its vibrational characteristics: the pedestrian and bicycle bridge “Ponte MOI”, the new symbol of Torino.

Photo: Hugh Dutton